Teaching kit on DNA structure based on the video Art Attack DNA structure.mp4

The video can be used as a guide for the realization of a model of DNA structure by using "poor" commonly available materials.

During model construction, students should pay particular attention to the following features of DNA helix:

- correct complementary base pairing
- uniform thickness of the double helix
- correct coiling of the double helix (leftwards)
- repetitive alternation of phosphate and sugar groups along the two strands

- The model production will be an effective learning moment (hands on learning).
- Once completed, the model can be used in a sort of "peer education" where students participating in its realization use it to explain the DNA structure to their classmates or to other students of different classes.
- The model (or a similar one) can be a useful tool for a flipped classroom approach, as outlined below.

Flipped classroom activity

1) Students are given the same basic knowledge that was available to Watson and Crick when they elaborated their model, that is:

- 1869: Miescher isolated DNA from the cell nucleus (hence its name), and characterized it as a slightly acid substance containing sugar and phosphorous.

- 1950: Pauling demonstrated that proteins can assume a helical structure stabilized by hydrogen bonds between close regions of the helix itself, and suggested that DNA could have a similar structure.

- In the same years, Wilkins and Franklin confirmed DNA helical structure by using X-ray diffraction.

- 1952: Herhey e Chase, by using bacteriophages, demonstrated that DNA (and not proteins) was the genetic material, responsible for the transmission of hereditary characteristics.

- In the same years Mirsky demonstrated that all the somatic cells in an organism contain the same amount of DNA, while gametes always contain half of it.

- In the meanwhile, Chargaff showed that the proportion of the four different nitrogen bases can vary among species, but it is the same in all the organisms of a given species. Furthermore, adenine percentage always corresponded to thymine one, as well as guanine percentage was equal to cytosine one (A/T=1 e G/C=1). Students can also be invited to derive by themselves Chargaff's conclusions, by looking at the following table, reporting nitrogen bases percentages in several organisms and cell kinds.

Organism	% adenine	% guanine	% cytosine	% thymine
Homo sapiens	30,4	19,6	19,9	30,1
Bos taurus	29,0	21,2	21,2	28,7
salmon spermatocyte I	29,7	20,8	20,4	29,1
wheat germ	28,1	21,8	22,7	27,4
Escherichia coli	24,7	26,0	25,7	23,6
sea urchin	32,8	17,7	17,3	32,1

2) Students are then invited to look at the DNA model and extract from it the fundamental structural information before referring what they have understood to their classmates.

3) Finally, the following questions can help verify comprehension:

1. Which chemical groups are responsible for DNA acidity and sugary properties?
2. Do you think that, because of such chemical groups, DNA is water soluble? Justify your answer.
3. If DNA were water soluble, we could not observe it once dissolved in water. What could we do to unravel its presence and observe its jelly-fish appearance?
4. As you can see, the molecule is a long polymer, formed by monomers differing for just one component. Which one?
5. If we look at the DNA double helix as if it was a ladder whose lateral supports are made of rope (like the one used by trapeze artists), what are the steps made of? Would it be more appropriate to speak of “half-steps”? And what are such “half-steps” made of?
6. Which are the bulkiest nitrogen bases? Looking at the model, can you see they occupy more space?
7. And what about the less bulky nitrogen bases?
8. Then, what does the obligatory complementary base pairing stem from?
9. What would happen if base pairing was random?
10. In a haploid cell, containing half the chromosomes of a somatic cell, do you expect to find 1:1 A/T and G/C ratios? Justify your answer.